U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 42.

FACTS ABOUT MILK.

(REVISED.)

BY

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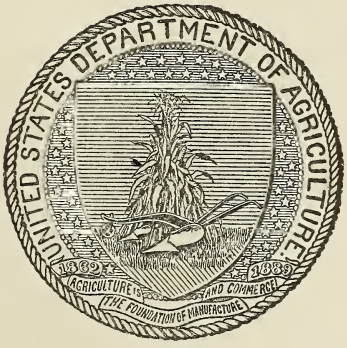

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., February 10, 1906.

Sir: I have the honor to transmit herewith and to recommend for publication a revision of Farmers' Bulletin No. 42, entitled "Facts about Milk," by R. A. Pearson, M. S., professor of dairy industry in the College of Agriculture of Cornell University. The original bulletin was prepared ten years ago while the author was assistant chief of the Dairy Division of this Bureau. It has had a large circulation and there is a continuous demand for such information. The article has now been revised and brought up to date by Professor Pearson under the direction of the Dairy Division.

Respectfully,

A. D. Melvin,
Chief of Bureau.

Hon. James Wilson,
Secretary.

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FACTS ABOUT MILK.

THE DAIRY INDUSTRY.

The production and distribution of milk and milk products engage the attention of no small part of our population. The use of milk is general and not limited to any class or locality; it is regarded as a necessity by almost every family and for this reason information regarding it is important. In the northern and eastern sections of the United States dairying is carried on very extensively; in large parts of these sections it is the chief occupation of the farmers. In the South and West the number of cows is rapidly increasing. This branch of agriculture is so widely practiced here that the United States is regarded as the leading dairy country of the world. In 1899 the annual value of our dairy products was estimated to exceed $600,000,000, and the value of the milch cows in the same year was over $500,000,000.

It would be impossible to closely estimate the value of all property devoted to dairying, but it can be safely said that in gross investment it is exceeded by few other branches of industry.[a] There are about 19,000,000 cows in this country, or about one to every four inhabitants; one cow, however, furnishes the milk, butter, and cheese for more than four persons, as some dairy products are exported. Although this is the greatest dairy country in the world, it does not lead in the per capita consumption of dairy products; one of the principal reasons for this is the failure of Americans to appreciate the food value of milk and its products. In some of the older European countries two or three times as much milk and cheese is consumed per capita as in the United States.

The average milk consumption is high in many parts of this country, and, owing to improved methods of production and transportation, it seems to be increasing. It is estimated that the milk from 5,000,000 cows is annually consumed, as milk, in the United States, the average being about 27½ gallons per year to each person; this means 0.6 pint, or a good-sized tumblerful, each day. Many use a much greater quantity, and consequently the number of those who use little or none must

[a] For the statistics of dairying in the United States, see Bulletin No. 55 of the Bureau of Animal Industry, Department of Agriculture.

be very large in order to make this average. Within recent years cream has become an important article of commerce, and in some localities condensed milk is extensively used.

The value of these foods is often much diminished or entirely lost because of lack of information on the part of the purchaser—and the producer and dealer as well—regarding the peculiar qualities of dairy products and the best methods of keeping and using them.

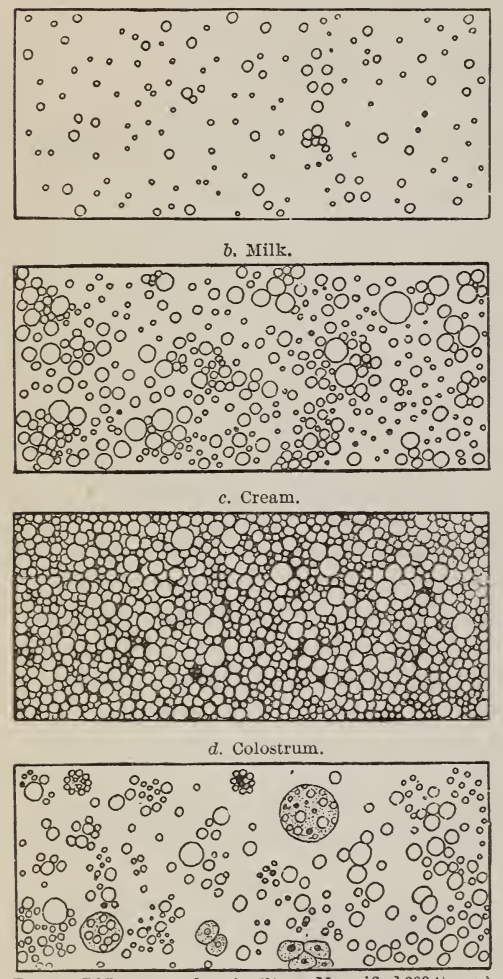


FIG. 1.—Different grades of milk. (Magnified 300 times.)

MILK.

Milk is a whitish, opaque liquid. To the ordinary observer it appears to be a perfect solution, and is commonly regarded as such, being bought and sold by liquid measure, but when placed under the microscope it is seen to consist of a clear, transparent fluid containing many minute globules of various sizes (fig. 1*b*). The fluid part, called the milk serum, consists of water and all the other constituents of milk except the fat; and these other constituents, although solids when separated and dry, are mostly all dissolved in the water, but part of them is in a state of fine suspension or partial solution. The globules are little bodies of pure fat scattered through the serum and not dissolved; they are semisolid and form with the serum a mixture called an emulsion.

CONSTITUENTS.

The solid constituents present in the serum in largest quantity are sugar and casein. Albumen and mineral matter are present in small quantity, and there is also believed to be a little fibrin resembling the fibrin of blood. In milk there is more sugar than any other solid component. This milk sugar can be separated from the solution and

brought into solid form; as sold, it resembles powdered white sugar. It is used to a considerable extent by druggists, also by manufacturers of certain proprietary foods, especially those for infants. It is not as sweet as cane sugar, but is fully as digestible, if not more so. Its commercial value is not sufficient to induce its manufacture in large quantities. Sugar is the constituent of milk which undergoes the greatest change when milk sours. Casein and albumen of milk are the chief nitrogenous constituents, and are generally referred to as including all of this class of substances in milk. They belong to the general class of foods which includes the lean meats and white of egg. Acid or rennet causes casein to coagulate, forming curd, and as such it is one of the chief ingredients of cheese, constituting about one-fourth of that important food. The albumen may be coagulated by heat. The mineral matter in milk, called ash or salts, is the part that remains when milk is evaporated to dryness and burned; this consists chiefly of phosphates and chlorides of soda, potash, and lime.

It is well known that when sugar is dissolved in water the solution is less limpid than pure water, and if many small bodies a very little lighter than water were thoroughly mixed into the solution their rise would be more or less retarded by the stickiness of the surrounding fluid. Milk might be compared to a thin sirup with many fatty and light particles floating in it, as just described. It is viscous or sticky, because of the solids held in solution and suspension; and this viscosity, together with fibrin, has a considerable effect in retarding the rise of the fat globules and the formation of the cream layer. The older milk is, the more effective are these forces. The fat globules are so small that a single drop contains many millions of them. It is said that if a person should attempt to count the globules in a drop of milk it would take ten years of his time, provided he counted at the rate of 100 per minute and worked ten hours per day six days every week. Such a number is too large to be appreciated. The globules average about one ten-thousandth of an inch in diameter, and twenty-five of average size placed side by side would about represent the thickness of ordinary writing paper. Globules of different sizes are found in the milk of any cow, but with certain breeds the sizes average larger than with other breeds. The milk of Jersey and Guernsey cows has this peculiarity, which explains why the cream rises so readily on it and why the skimmed milk is so thin and poor, large globules naturally being able to get to the top more quickly than small ones, many of which can not rise at all.

COMPOSITION.

One hundred pounds of average milk contains about the following amounts of the different constituents: 87 pounds of water, 4 pounds of fat, 5 pounds of milk sugar, 3.3 pounds of casein and albumen, and 0.7

pound of mineral matter or salts. These proportions are graphically shown in the accompanying illustration (fig. 2).

But the quantities of the constituents vary between wide limits. The total solids of milk, meaning all the constituents except water, may be as low as 10 or as high as 18 parts in 100. This variation is due to several causes, some of which are given later. The fat varies in quantity more than any other part of the milk, running as low as about 2½ parts in 100 and as high as 8; the larger the proportion of fat the richer the milk is said to be. Most of the States and many cities have a legal standard for the composition of milk, and any milk falling below this standard is legally regarded as adulterated although it may be, in fact, the natural product. The laws usually require 3 or 3½ per cent of fat, and 9 or 9½ per cent of "solids not fat." (This term is commonly

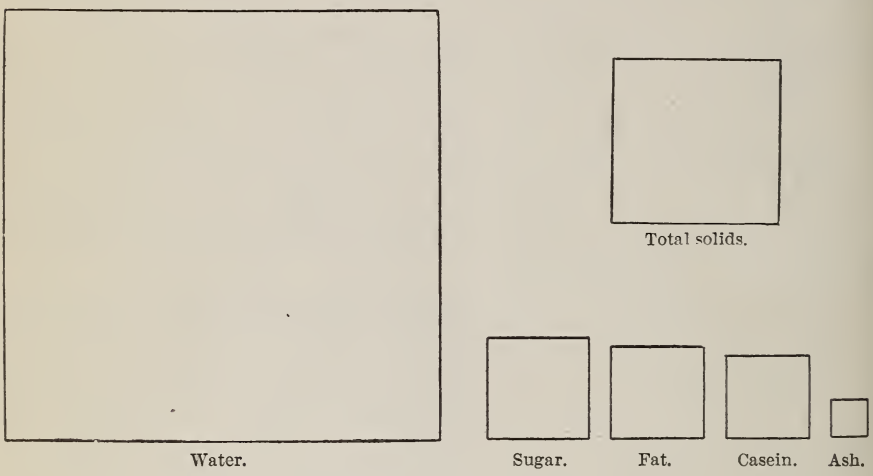


FIG. 2.—Proportions of the component parts of milk.

used to designate all the solid substances of milk other than fat.) The total solids required thus vary from 12 to 13 per cent, according to different laws, which means, of course, that in every 100 pounds of milk there shall be 12 or 13 pounds of solid matter. These legal requirements are justified by the fact that it is the solid matter and not the water which gives value to milk.

The fact that the standard so often relates to the proportion or percentage of fat and the popular impression that milk is without value after the cream has been removed lead some people to think that fat is the only valuable part of milk. This is a great error. The several other constituents are valuable; for example, casein is one of the cheapest forms of nitrogenous food and is more nutritious than similar compounds in many other foods. It is, of course, safe to judge of the quality and value of milk by the fat it contains, because, if milk

is poor from either natural or unnatural causes, the quantity of fat will be affected at least as much and oftentimes more than any other constituent.

CAUSES OF DIFFERENCES IN THE COMPOSITION OF MILK.

The composition of milk depends largely upon the kind of cows producing it. Jerseys and Guernseys, by some people called Alderneys, produce a rich milk, in which most of the fat rises and forms the cream layer quickly. It has been explained that this is because the fat globules are relatively large. This is a decided advantage to those who wish to raise cream, but not if the milk is to be used whole. It may be a positive disadvantage, in some cases, to have the cream separate too soon. Durham and Ayrshire cows give milk of an average quality from which the cream rises slowly, and on this account they are sometimes said to be good "milkman's cows." Holstein milk usually has a small proportion of fat or cream, but some families of these "black and whites" supply a product of excellent quality. The Holstein cows are noted for producing enormous quantities of milk.

Although these statements refer to pure-bred cows of the different breeds named, they also apply to grade animals having one-half or more of the blood of these breeds. But in either case, especially the latter, there are many exceptions to the rule. All cows of the same breed do not give milk of the same quality; in fact, the composition of milk from individual cows of the same breed sometimes varies as much as that from cows of different breeds. It is a popular notion that the feed given a cow influences the quality of her milk more than anything else; but if a cow in normal condition gives a rich milk at one period, her milk will be of good quality at all times, unless she is badly neglected or diseased. Feed has a much greater influence upon the quantity of milk produced than upon its quality.

The first milk given after calving is called colostrum (fig. 1, *d*). It contains a large proportion of albuminoids and is somewhat laxative. It is not fit for food, except for the newly born. In natural milk a small amount of albumen is present, but in colostrum the albumen often exceeds the amount of casein, and these two constituents may form over 15 per cent of the milk. The percentage of sugar in colostrum is usually low; the fat is usually about normal, though it may be in excess or deficient. The composition of colostrum changes rapidly, and within a few days after birth of the calf natural milk is given. After this the percentage of fat in the milk from any cow varies more or less from day to day, even if her feed, care, and general treatment are always alike. The causes of the sudden changes are not always known; in fact, the fat often seems to increase or decrease without any cause. Sometimes the fat content changes as much as one-

third within twenty-four hours. As the period of lactation progresses there is a tendency to a gradual increase of the total solids and the physical condition of the milk is so altered that cream rises less easily.

In well-regulated dairies each cow is milked about ten months of the year; the remainder of the year she is said to be "dry." Where a dairyman takes the product of his herd to a cheese factory it is the custom to have all the cows give milk in the summer time and none in winter, but where he supplies milk for retail customers he endeavors to have only a small part of the herd dry at one time, so there will be always enough cows in milk to supply his trade. An incidental advantage of this is that the milk from fresh cows is added to that from cows more advanced in the milking period, and the changes due to the time of lactation are avoided in the mixed milk, which is thus kept of uniform quality.

DIFFICULTIES IN OBTAINING PURE MILK.

The first thing to be borne in mind is that milk is naturally a pure product. If any milk is found unclean, unwholesome, or disproportioned in its proper parts, the chances are that it is not the fault of the cow. In all such cases the presumption is that some person is to blame, either the one who cares for the cow or the one who handles the milk. If those who buy milk used proper care they would have little trouble in always procuring a good clean article. It is possible to produce milk free from harmful contamination, and if impure milk is delivered the dairyman or dealer may be held responsible, and it is the duty of the customer to reject it. When the milkman knows that his customers will not accept poor or unclean milk, he will stop offering it.

On the other hand, some people are most unreasonable in their complaints and demands upon their milkmen. This and the sharp competition between rival dealers are two chief causes of dishonesty in the milk business. When a milk peddler knows that he is delivering the best of milk and complaint is made that it is not yellow enough or has not enough "body," and he is afraid of losing a good customer, he is naturally tempted either to give that person a supply from near the top of a can, thus depriving some one else of cream which rightly belongs to him, or to do what he thinks his dishonest competitor is doing, whatever that may be. There is a great desire on the part of purchasers to get milk cheap, and it is not an unknown thing for customers, including hotels and private institutions as well as private families, to demand such large measure for their money that the dealers feel compelled to "extend" the milk in order to meet these requirements and prevent loss of trade. Some are satisfied with the adulterated stuff, not knowing that the same amount of actual food, but no

more and perhaps less, is being delivered in the large measure than was formerly delivered in the smaller one. This explains how it sometimes happens that milk is retailed in cities at less than the regular wholesale price. People too easily forget quality and think only of quantity. The only sensible thing for the housekeeper or other buyer of milk to do is willingly to pay a fair price and insist upon good milk in return. Buyers should remember that at the highest prices usual anywhere good milk is one of the cheapest articles of food that can be purchased.

It should also be borne in mind that milk can be contaminated as easily after delivery to the consumer as before, and too often a milkman is blamed for bad milk or cream when it was made so by conditions over which he had no control. If left where dust can settle in it or flies have access to it, or if set in an illy ventilated cellar, in a warm place, or where it can absorb odors, it is pretty certain to be in bad condition after a few hours, no matter how good it was when delivered.

Numerous well-authenticated cases are known where customers have complained of milk received, and upon investigation it has been proved that servants in the house tampered with the milk, removing cream for their own use or adding old milk or vinegar to make it sour prematurely. The object of the latter act was, in connivance with an outsider who supplied the motive, to cause the buyer to change to some other dealer whom the servant was ready to recommend.

Attention on the part of consumers to the proper way of producing and handling milk would result in a great improvement of this most important food. Laws may do much to prevent fraud, but customers who know exactly what they want, how to get it and how to care for it, have a much greater effect on milk producers and dealers than any possible laws.

CHANGES IN MILK.

Pure as milk may be in its natural state, it is a perishable product, and although with a proper knowledge of its peculiarities and care in its keeping it can be held in a wholesome state a reasonable length of time, there are natural changes which are sure to occur as soon as opportunity is given. Thunderstorms, impurities, warm temperature, and other conditions known to exist when milk is most liable to give trouble have been blamed for its changes. But it is now known that these are only indirect causes, and that the changes in milk which bother the housekeeper are due to and can not take place without the presence of minute organisms called bacteria. The souring of milk and other changes or fermentations have been discussed in Farmers' Bulletin No. 29, issued by the Department of Agriculture. That bulletin describes

the bacteria and various fermentations of milk, including the common changes and those which cause it to become blue, bitter, slimy, or ropy, and treats of the practical bearing of the subject upon dairying.

Any milk showing a sediment is suspicious. Particles of dirt are a sign that germs are abundant. Thus dirty milk may be dangerous as well as disgusting. The dirt in milk consists mostly of particles of dust, dead skin, manure, and hairs which fall into the pail from the body of the cow during milking; but dust in the stable, dirt and dust in the vessels used for handling milk, and unclean attendants are also common sources of dirty sediment in milk.

Milk from unhealthy or unthrifty cows or that which has been handled by sick persons is dangerous, as it may contain infectious germs or foreign substances which might affect the health of the consumer. Typhoid fever, scarlet fever, diphtheria, and consumption (or tuberculosis) have been spread by milk. Feverish cows, those having just given birth to a calf, and sometimes cows that have been milked a long time, produce milk which should not be used. Any milk having an unnatural appearance should be discarded.

Odors and peculiar flavors are due to bacterial action or to the volatile oils of some foods; onions, turnips, cabbage, and certain weeds, as garlic and wormwood, give characteristic odors and tastes to milk. When odors or flavors are most marked at the time milk is first drawn, they are generally due to food eaten by the cow. When they are slight at first and gradually increase as the milk becomes older, they are generally due to the growth of bacteria.

ADULTERATION.

The most common forms of fraud practiced with milk are the removal of a part of the cream and the addition of water. Color is sometimes added, but the addition of chalk, burnt sugar, salt, or other substances, although often charged, is in fact quite rare. The mixing or blending of milk means the mixing of good milk with poor milk to obtain an average quality. Sometimes skimmed milk is mixed with a lot of good quality to make a medium grade; this practice amounts to exactly the same as removing a part of the cream. Most communities have laws against adulteration, but they are not always rigidly enforced. Adulterated milk is objectionable in proportion as it contains less food value than represented, and the consumer is deprived of nourishment which is supposed to be given. But this is not the worst about milk that has been adulterated by water. If a dairyman is dishonest enough to water his milk he will probably not be careful about the purity of the water added. Impure water contains many bacteria. Most of them are harmless, but in an immense number there are likely to be some dangerous species, such as disease germs

and bacteria producing changes in milk which cause diarrheal disturbances. Epidemics of contagious diseases have been traced directly to contaminated water added to milk for the purpose of adulteration, or which had been used to rinse the cans.

PRESERVATIVES.

Various chemicals are sometimes added to milk to prevent its souring, but there are strong objections to them. The most common of these substances contain salicylic acid, boric acid, borax, or formaldehyde. They are not regarded as poisons, but when taken regularly in small doses in milk they may have an injurious effect on the system. They, or mixtures of which they form a large part, are sold under many different names, and are sometimes used also in canned fruits and vegetables. Boric, or boracic, acid is more powerful in its physiological action than borax; both are strong antiseptics. Salicylic acid is a white crystalline powder that is odorless and tasteless. It was once used so extensively in France that fears were entertained lest it would have a detrimental effect on the public health, and a commission was appointed to investigate its action. Their report stated: "The addition of salicylic acid or its derivatives, even in the most minute amounts, to foods, solid or liquid, should not be authorized." The United States Dispensatory says: "Salicylic acid has been used for the preservation of various articles of food, but the employment of it should be interdicted." Formaldehyde is a powerful germicide, which has been shown to have an adverse effect on the digestibility of casein. Public opinion is now strongly against the use of these substances, and the laws of numerous States and cities prohibit them. Small continued doses of preservatives may not affect many people, but may harm others, and no one can tell who might have an idiosyncrasy toward them. Salicylic acid and its salts are eliminated by the kidneys, and as these organs become less active in the aged they feel the effects more than the young. It is easily seen that in the same way in which preservatives prevent the natural changes of milk they may prevent its digestion in the alimentary tract, the process of digestion being similar in many respects to the familiar fermentations. The danger from the use of preservatives would be much less if they were handled only by intelligent persons; a very small amount is sufficient to prevent milk or cream from souring, but an ignorant person is likely to think that if a little is good, more would be better, and so use much more than necessary. Another objection to chemical preservatives is that one accustomed to their use may get in the habit of depending on them so much that he would use even less care with the preserved milk than if it were not preserved.

CARE OF MILK AFTER DELIVERY.

The proper care of milk after it has been delivered to the consumer is a matter of great importance. It is desirable to have it in the best possible condition for use, and it is not desirable to blame the milkman for things for which he is not in the least responsible. If milk is kept in an open vessel in a refrigerator with meats and various kinds of vegetables, it will absorb odors from them. It is also sensitive to flavors, and if allowed to stand in an old tin vessel the "tin taste" can be easily recognized. Milk should therefore be kept in a cool place, free from odors, and in a perfectly clean vessel of suitable material. A well-glazed earthen or porcelain dish, or a glass jar or bottle, is the best container; tin is good so long as it is bright and the iron is well covered. Wooden dishes are objectionable.

FIG. 3.—Dairy thermometer.

As already stated, the change to which milk is most liable is simple souring. The best agent to prevent this change is cold or heat. There should be no trouble in keeping milk sweet at a temperature of 50° F. from twenty-four to thirty-six hours after it is in the hands of the customer. This can be done if it is delivered in good condition and properly handled after delivery. It is the custom in some places to leave the milk in open vessels on the doorstep early in the morning, and it often remains there exposed to heat, dust, insects, and small animals until wanted in the house. This is a dangerous practice. In hot weather milk exposed in this way for any length of time ought to sour soon, and if it does not it is probably due to the presence of preservatives. Too much care can not be used in seeing that the milk is cold when delivered, and that it is then immediately put into a cool place. If allowed to stand in the warm air, even for a few minutes, the time it will keep sweet is shortened.

Sometimes milk does not keep sweet when no cause can be discovered for its souring. This is frequently the case in summer. Often the trouble is the refrigerator, which may seem cold on account of the great difference between its temperature and that outside, while it is, in fact, not cold, and a thermometer may show its temperature to be even above 60° F. A floating dairy thermometer (fig. 3) is a convenient article to have in the house. It is a closed glass tube with a paper scale inside; it can be put into a liquid without injury, stands upright in the liquid, and is easily cleaned. The temperature of the milk should occasionally be taken when it is removed from the ice chest and the cause of early souring may be found. A temperature above 50° F. never should be allowed, and it is better to keep it down to 45° or 40° F.

PASTEURIZATION OF MILK.

The practice of pasteurizing milk is being followed by some dealers who find that it greatly reduces the number of complaints they receive on account of sour milk. The treatment consists of heating the milk to a temperature, usually between 140° and 160° F., at which large numbers of bacteria in the milk are killed, and then cooling it to check the growth of others. If sufficient heat were used to kill all the germs the product would be called sterilized milk, and it might be kept in good condition indefinitely. Unfortunately the higher heat renders milk objectionable to most consumers, by changing its taste and appearance, and perhaps slightly reducing its nutritive value.

Special kinds of apparatus are used for pasteurizing milk on a large scale, and those generally preferred by the dealers are called continuous pasteurizers because they do their work continuously. They are arranged so that the milk to be pasteurized flows through the apparatus in an uninterrupted stream, being heated by passing in a thin layer over a metal surface on the opposite side of which is steam or other heating agent, and being cooled in a similar manner in the same apparatus or another close at hand. Care is taken not to allow the temperature to go so high that a disagreeable cooked flavor is produced.

The pasteurization of milk is desirable when the milk contains large numbers of harmful bacteria, and especially when it is thought to contain some pathogenic or disease-producing bacteria.

The importance of doing the work thoroughly can not be overstated. The temperature must be high enough, and must be retained long enough, to kill disease-producing organisms such as those of typhoid fever. Care must be taken to avoid scorching the milk, and it must be thoroughly cooled and protected from contamination after being heated.

Some persons go so far as to advocate the pasteurization of all market milk in plants controlled by the municipalities. But there are objections to the process as well as advantages, and it is doubtful if it should be adopted except where special need exists. An important objection is that some of the worst types of bacteria are not killed by pasteurizing temperatures, and these grow in the pasteurized milk whenever the temperature permits. Furthermore, they grow more rapidly in pasteurized than in raw milk, because the "sour-milk" organisms, which would be antagonistic to them and hold them in check, have been largely destroyed by the heat. Thus it is possible for objectionable and even dangerous changes to take place in pasteurized milk without being apparent, and a consumer may use highly contaminated milk without knowing it until bad effects are caused. He is warned against common souring which takes place in raw milk

by the appearance, taste, and smell of the milk. Some of the strongest champions of pasteurization recognize this objection and advise that it be done not more than twenty-four hours before the milk is consumed, so as to avoid the possibility of extensive bacterial changes without accompanying warning signs as described.

The pasteurization of milk in the home is an easy operation, and mothers should know how to do it, as the necessity may arise at any time. Of course it is best to have clean wholesome milk that does not need to be pasteurized, but sometimes this is impossible and the only milk available for the little ones is from unknown sources and is teeming with bacteria. Undoubtedly such milk has cost many young lives. It is estimated that one-third of all children die before they are 3 years old, and one of the leading causes of infant mortality is unwholesome milk. Bad milk can not be made perfect by pasteurization, but the danger from its consumption can be lessened. The Department of Agriculture has issued circulars giving full directions for pasteurizing milk in small quantities. The process is simple and the necessary apparatus is inexpensive.

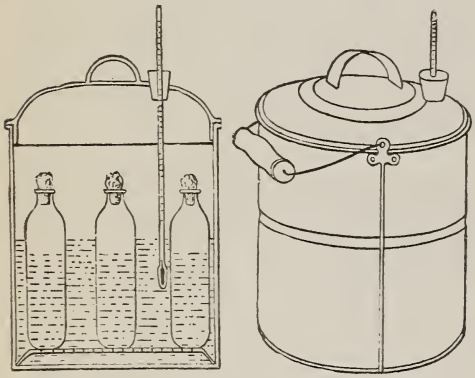


Fig. 4.—Pasteurizing apparatus.

Briefly, the directions are as follows: One or more bottles nearly full of milk are plugged with dry absorbent or other clean cotton and placed in an upright position in a vessel having a false bottom and containing enough water to rise above the milk in the bottles (fig. 4). The vessel is closed, placed on the stove, and heated until the water is 155° F., or even to boiling if special precautions are deemed necessary. It is then removed and kept tightly covered for half an hour. A heavy cloth over the vessel will help to retain the heat. The milk bottles are then taken out, cooled as quickly as possible by cold water or ice, and kept in a cold place. Milk thus prepared may be expected to keep twenty-four hours, and should preferably be used within that time. The cotton plugs should be kept as dry as possible and should not be removed until the milk is to be used. A covered tin pail answers well for the larger vessel. An inverted pie pan with perforated bottom can serve as the false bottom. A hole may be punched in the cover of the pail, a cork inserted, and a chemical thermometer put through the cork so that the bulb dips in the water, thus enabling one to watch the temperature closely without removing the cover, or an ordinary dairy thermometer may be used from time to time by removing the lid.

CREAM.

When it is desired to raise cream the milk should be put in a cold place, where it will not be disturbed, as soon as possible after it is received. A good quality of cream for table use can usually be obtained in this way. (See fig. 1, *c*.) It will aid the cream in rising if the temperature of the milk is raised to about 100° F. and then lowered by placing the dish in cold water. This can not be done unless the milk is in good condition, as the high temperature may cause it to sour before it will cool sufficiently to prevent souring. Milk jars or bottles are now extensively used, and if they are filled when the milk is fresh, and carefully handled, the cream will show plainly within a few hours, and much less time is required for it to reach the top after it has been delivered than when it has been mixed just previous to delivery. Thus by the use of the jars considerable time is saved and fresher cream can be obtained. The jars may be purchased from any dairy supply company at a small cost, and provide a neat, clean way of handling milk.

Separator cream can be made much richer than "gravity" cream, and for this reason is preferred for whipping and some other purposes. It may be kept longer, as it can be taken from perfectly fresh milk, while that raised by gravity is usually 12 to 24 hours old when skimmed. Cream gradually becomes thicker the longer it is kept, and it is often held for this purpose. Sometimes it is 1 or 2 weeks old when used; very little is used in as fresh condition as milk. For this reason special care is needed to keep it sweet. Satisfactory results are not obtained by placing it in a refrigerator at a temperature of 50° F. It ought to be kept as near the freezing point as possible; it should be placed directly in contact with the ice or, better yet, be entirely surrounded with ice. Good efforts will be wasted if the ice comes up only halfway and the top part is exposed to a warm temperature—it must be cold throughout. Skimmed milk and buttermilk should have the same care as whole milk.

DETECTING IMPURE MILK.

Some of the more common forms of impure milk already have been noted. By pure milk is meant the properly handled product of healthy, well-fed cows. To be legally regarded as pure, in most places, milk must contain at least a certain amount of fat and other solids. It is a difficult thing to determine by the appearance of milk whether it is pure or not, and even experienced dairymen are frequently unable to do this. It has a slightly yellowish white color, a very slight odor, if any, and should have a distinctly sweet and pure taste. When allowed to stand

quietly for several hours, cream should rise naturally, and if the separation is thoroughly effected the cream should form one-eighth to one-fifth of the total volume or bulk. No sediment should appear in the bottom of the jar or vessel. When good milk is poured from a tumbler it should cling to the glass a little and not run off clean like water. Skimmed or watered milk is thinner than whole milk and of a lighter shade, being of a bluish-white color. The yellow shade of milk is chiefly due to its fat, but as this constituent is more yellow in the milk of some cows than others the yellowest milk is not necessarily the richest, and it is unsafe to judge by the color alone; poor milk from some cows may be more highly colored than rich milk from others. Besides this, artificial colors are sometimes added by dishonest persons.

When a quantity of milk is to be tested, the first and most important thing to be done is to obtain a fair sample—one that will represent the whole and show its average composition. If the sample is taken from near the top or bottom of a vessel of milk which has been standing quietly for even a short time, it will be too rich or too poor in fat. The milk must be well and thoroughly mixed before the sample is taken. A good way of doing this is to pour it several times from one vessel to another. This should be continued until no lumps or collections of cream appear on the surface. If small particles of butter are floating about, a fair sample can not be taken. There are several methods of testing milk. A complete analysis by a chemist will give the exact amount of each component part. This requires considerable time and expense, and is not necessary for practical purposes.

THE CREAMOMETER.

A very simple test, and one which, although not altogether reliable, is better than none, is the judgment of milk by the amount of cream it will show. This is not an accurate test, because it may fail to show cream when it should or it may show more than it ought; however, it will not show cream if there is none in the milk. With two samples of milk having the same amount of fat different results may appear with this test, as the proportion of the fat globules which rise depends on certain conditions, including the size of the fat globules and the age of the milk and the way it was handled before delivery. If fat globules have much difficulty in rising, only a small part of them will get to the top and they may carry up with them so much of the other constituents that there will be a large bulk of poor cream. When the test is carefully conducted and conditions are favorable to the rise of cream, fair results can usually be obtained. This test requires a long, graduated glass tube (fig. 5), which is filled with milk to the zero mark and allowed to stand in a cool place for twenty to twenty-four hours.

The cream may be aided in rising by warming the milk to 100° F. and then setting it, in the tube, in cold water, or the tube may be filled half full of milk and the remainder with warm water, which raises the temperature and reduces the viscosity; in such case only half as much cream will appear as the milk is to be given credit for; for example, if the contents of a glass are half water and show 10 per cent cream upon the scale, this means, of course, 20 per cent of the milk. If the milk is the same each day and is tested in the same way, there should be little difference in the cream shown. Tubes graduated specially for this test are sold by dairy-supply firms. The cream test furnishes a good opportunity to look for sediment; if the milk is not clean, dirt can be seen in the bottom of the cylinder. Care should be taken to carry the tube quietly, so that neither the cream nor the sediment will be disturbed.

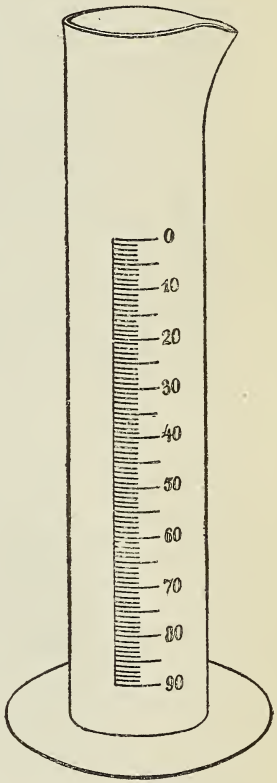


FIG. 5.—Creamometer.

LACTOMETERS.

Milk is a little heavier than water. Its specific gravity varies from 1.029 to 1.033, which means that the weight of pure milk varies from 1.029 to 1.033 times the weight of water. Departures from the standard weight, such as those due to the quality of the natural milk or to skimming or watering, can be measured by an instrument called the lactometer. This is a weighted glass bulb with a slender stem bearing a graduated scale, and it is so adjusted that when placed in pure milk it will sink until some point on the scale is even with the surface of the liquid. This point is called the reading. Different kinds of lactometers are graduated in different ways. A style frequently used and known as the board of health lactometer registers 100 when the specific gravity is 1.029, and less than 100 when the specific gravity is less than 1.029. A specific gravity of 1.033 would be indicated by 114 on this lactometer.

The Quevenne lactometer is graduated from 15 to 40 and indicates directly the specific gravity. Thus at 60° F. it would read 32 in milk having a specific gravity of 1.032 and it would read 30.5 in milk having a specific gravity of 1.0305. The best forms of lactometers have a thermometer in the stem above the lactometer scale so that the tem-

perature of the milk can be taken at the moment the reading is recorded. If the temperature is above or below 60° F. the lactometer reading must be corrected, and with the Quevenne lactometer the correction is made by adding 0.1 to the reading for each degree of temperature above 60° or subtracting 0.1 for each degree of temperature below 60°. Thus, if the Quevenne lactometer reading is 31 in milk having a temperature of 56°, the corrected reading would be 30.6 and the specific gravity at 60°, 1.0306.

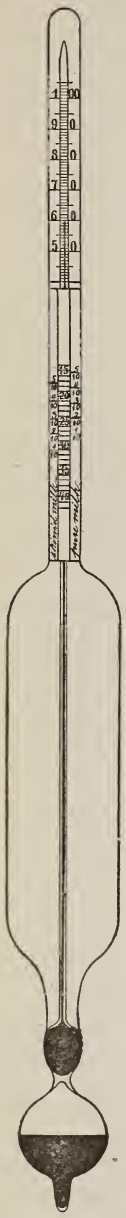


FIG. 6.—Lactometer.

Accurate as these instruments are, they can not do more than show specific gravity. If cream, which is lighter than milk, is removed, the specific gravity is increased; and if water is added, the specific gravity is decreased. Therefore if a sample of milk has a high specific gravity, skimming is suspected; while if it has a low specific gravity, watering is suspected. But if some cream is removed and water is added in proper proportion, the specific gravity may remain unchanged; and this is one of the commonest ways of all for adulterating milk. If such fraud is extensively practiced it can be detected by the creamometer test or, more surely, by the Babcock fat test described on the following page.

A fair opinion of the value of milk, so far as its composition is concerned, can be formed from the percentage of fat, as the total solids of normal milk increase and decrease as the amount of fat is greater or less. If milk has been tampered with by watering, the percentage of fat is reduced in the same proportion as the other constituents, but in a greater proportion if the milk is skimmed. As fat is the part that the dishonest person tries to abstract, the purchaser is on the safe side if he judges of the quality of the milk by the fat which it contains. Many tests for the fat of milk have been proposed. The lactoscope and other optical methods are sometimes used to determine the fat or "oil," but they are inaccurate, and especially so in the hands of one without large experience. Some of them depend on the color of the milk or on the fact that the more fat there is, the less light will pass through a thin layer. But as the color of milk is not an indication of its richness, and the same amount of fat will retard more light when in small than when in large globules, these methods may give incorrect results and are therefore unreliable.

THE BABCOCK TEST.

Several methods of rapidly determining the fat content of milk with the aid of chemical reagents have been devised. One of the most accurate is the Babcock milk test.[a] The little machine constructed to apply this test, and of which several patterns are made, is in use in almost all well-conducted milk-receiving stations. It requires about a tablespoonful of milk for a sample, and the exact percentage of fat in it can be determined by this test in ten to fifteen minutes. The result is obtained by the action of centrifugal force aided by some chemical agents. The original cost of the machine is from $4 to $15, according to size and pattern, and less than 1 cent's worth of materials are used for each sample. Its manipulation is easily learned, and it can be successfully operated by any careful person. A definite amount (18 grams[b]) of the milk or cream to be tested is measured in a pipette and placed in a bottle which has a long, slender, graduated neck (fig. 7); sulphuric acid is then added, and the bottle shaken until the mixture becomes dark colored, which requires but a few moments. The acid does not affect the fat, but it dissolves the other milk solids which keep the fat globules apart.

The bottle is then placed in the machine, by which it is rapidly revolved in a horizontal position with the neck toward the center. The fat is thus forced toward the neck by the other contents of the bottle, which are heavier and therefore thrown away from the center to the bottom of the bottle. Sufficient warm water is added to bring the fat up into the neck, where its exact percentage can be read on the scale. In the illustration a pipette for measuring the milk, the acid measure, and a test bottle are shown. From two to twenty-four bottles, containing as many different samples, can be tested at a time, according to the size of the machine. Special bottles of a

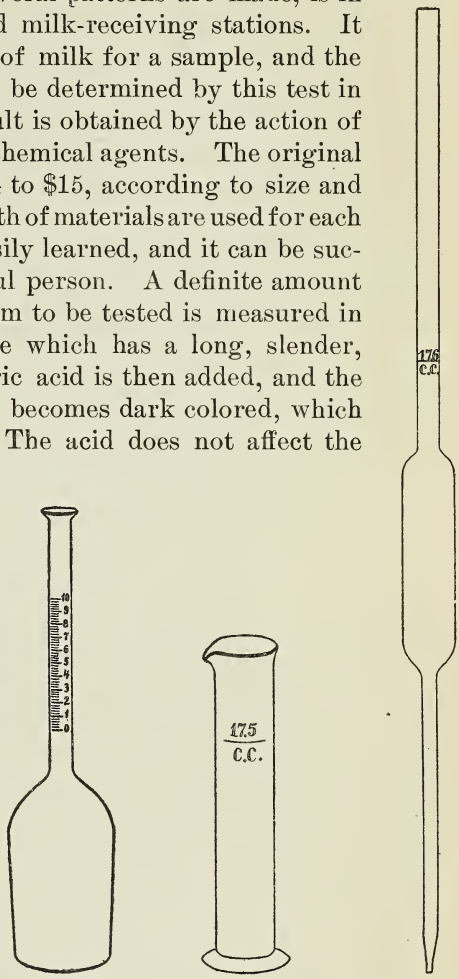


FIG. 7.—Glassware for the Babcock fat test.

[a] Invented by Dr. S. M. Babcock, of the Wisconsin Agricultural Experiment Station, and fully described in bulletins of that and several other experiment stations.

[b] 17.6 c. c. of milk weighs practically 18 grams. Cream is lighter than milk; hence a larger volume must be taken. For exact results, cream samples should be weighed.

modified form are furnished for testing skimmed milk and cream. Apparatus for this test is sold by dairy-supply firms. A small machine, complete with the necessary glassware and acid, can be obtained for $5 or $6. Full directions are sent with the apparatus. These can be easily followed and quite accurate results obtained after a little practice.

A number of other tests which can be quickly and easily made have been described by different investigators. Like the Babcock test, they are for the determination of the fat only, but are less satisfactory. Some testing appliances have been placed on the market with the necessary chemical agents in bottles designated by a letter or number, without information as to the character of the liquids. These have to be used without sufficient knowledge of their nature, and they are apt to be unduly expensive. Ether is sent out in this way. This is not safe, as considerable damage might result from an inexperienced person handling such a highly inflammable or explosive substance.

If the honesty of the milkman is questioned, it would certainly be a good plan to have a tester on hand for determining fat, and it should occasionally be used. Some new test requiring only cheap apparatus and reagents, not dangerous even in the hands of an ignorant person, which would show, within one-half of 1 per cent, the correct fat content of a sample of milk, and which could be operated with little labor, would be most welcome to housekeepers.

ACID TEST.

Acid commences to form as soon as milk is drawn from the cow, and after a certain amount has been developed it becomes evident to the taste, and the milk is said to be sour. It is sometimes desirable to know whether milk is near the souring point or not, or if it is fresh enough for the use of a baby or delicate person. It is well known that milk which is almost sour will coagulate on boiling, but this test does not show whether the amount of acid present is small or great. Mann and Farrington have devised simple methods for determining the amount of acid in milk. The method of the latter is the more convenient for household use. Tablets containing a definite quantity of alkaline material (such as caustic potash or soda) are dissolved in water and added to a measured amount of the milk to be tested. The tablets contain a little phenolphthalein, which is colorless when in acid solution and pink when in alkaline solution. A solution of these tablets is slowly added to the milk and the mixture is stirred until it becomes pink. It is then known that enough alkali has been added to neutralize the acid in the measured amount of milk and the amount of solution required indicates the acidity of the milk.

Perfectly fresh milk contains very little acid and would turn pink by the addition of a small amount of alkali, while milk nearly sour

contains more acid and would require much more of the solution to turn it pink. The tablets are made of such strength that, if a solution of two of them turns one ounce of milk pink, that milk should keep a reasonable length of time with proper care. If the milk remains white after the solution has been added to it, it will probably soon sour. This is a very simple, inexpensive, and useful test, and requires only milk enough to fill an ounce bottle. If this test were adopted for household use, one could soon ascertain how much of the alkaline solution should be necessary to turn a definite amount of milk pink at the time of delivery, and then refuse any not up to the standard.

It has been stated that colostrum, or the first milk given after calving, contains a large percentage of albumen, and should not be used for ordinary purposes. Albumen is coagulated by heat, and when colostrum is boiled a large coagulum is formed. If perfectly sweet milk coagulates on boiling, the indications are that it contains too much albumen, and it should not be used.

The foregoing tests are all good so far as they go, but none of them show whether the milk is from healthy cows or whether it has been contaminated by germs of disease. The adulteration of milk may produce bad results by diminishing the food value, but intelligent persons will learn sooner or later that they are being cheated, especially if the practice is carried on to a great extent. By far the greatest amount of harm that is produced by milk is due to objectionable bacteria which it contains. An inconceivable number of these organisms may be present in milk and their presence not be noticed, and the only way in which they can be detected is to note the changes of the milk or have a bacteriological examination made, which involves time and expense. No test has been devised that will quickly and easily show the presence of disease germs in milk. It has already been stated that bacteria get into the milk of healthy cows after it is drawn, and the best way to keep them out is to avoid, as much as possible, exposing the milk to them. This means that the dairy and its surroundings must be clean, and clean all the time. Filth can not be present in any degree without having a contaminating influence.

SELECTION OF DEALER.

Undoubtedly the best way to secure a good milk supply is to deal with a dairyman or milkman who is thoroughly honest and scrupulously clean. He should be required to show quarterly certificates from a veterinarian of good standing, stating that after a careful examination of his cows they were found to be healthy; that if the health of any was even doubtful such animal had been removed from the herd; that the quality of the feed and water, the sanitary conditions of the stables and

surroundings, and the health of the employees were approved. His own honesty and experience should be sufficient guaranty as to good measure and quality and that his milk has been properly cared for and guarded against exposure. The certificate of the veterinarian should be sufficient guaranty as to the good health of the herd and correct sanitary conditions of the establishment. It is a mistake to consider that milkmen are naturally a lot of tricksters. Honest men are in this business as well as any other, and one of the most important steps toward securing honest milk is to encourage the honest man by giving him deserved trade. The milk commissions operating in some of the large cities serve this purpose. They approve or "certify" the milk of dairies which are conducted in the most careful manner.

Laws have been in force for many years in most of our cities requiring a certain composition of milk as the minimum. Usually the requirement is at least 3 per cent fat and 12 per cent total solids. These regulations are undoubtedly a great benefit so far as they go, but in many towns and cities there are no such laws in force, and in order to secure a good quality of milk the great majority of milk consumers rely on the intelligence and honor of the one who supplies them. One of the best incentives for a dairyman or dealer to keep his dairy as it should be is to feel that he may expect a visit at any time from some of his customers. The practice on the part of consumers of occasionally visiting the farms and stores from which their milk comes can not be too highly commended. When one does this he should take special care to know that he is not visiting a sample farm which is always kept ready for inspection, while others, perhaps more distant, are not in such good condition. His milk may come from those more distant. On a well-conducted dairy farm one may expect to find these conditions:

A roomy, clean, dry, light, and well-ventilated stable or cow house. To produce good milk, cows must be comfortable, and these conditions not only add to their comfort but are absolutely necessary to keep them in the best of health.

Healthy and clean cows, which appear well-fed and contented.

An abundance of pure water to which cows are given access at least twice a day.

Feed of good quality; the grain and coarse fodder should be free from dirt, decay, or a musty condition.

A spirit of kindness toward the stock, exhibited by everyone employed about them, and gentleness of the animals themselves.

Provision for washing and sterilizing or scalding all utensils which come in contact with milk, and preferably the use of milking pails with small top openings, which do much to keep dirt from falling into the milk.

Provision for straining and cooling the milk in a clean atmosphere, free from all stable and other odors. This treatment should take place immediately after the milk is drawn from each cow.

Facilities for storing the milk and keeping it cold.

Especially great cleanliness in regard to everything connected with the dairy. The air of the stable should be pure and free from dust when milking is being done. Employees should carefully wipe the udders and then wash their hands before milking, and should be in clean clothes. Whitewash is a good disinfectant, and should be seen in many more stables, and land plaster should be sprinkled about to absorb moisture and odors. The cow should stand on clean litter and not dirty stuff which could be used nowhere else.

If it is suspected that milk is being adulterated, a sample might be taken by the visitor when on the farm. This should be handled as nearly as possible like the daily supply, and compared with it as to amount of cream, or, better, as to the amount of fat.

If the milk is handled through a store in the city, the building should be kept scrupulously clean, and the room in which the milk is exposed should be free from dust. There should be provision for keeping the milk cold when stored, and apparatus for steaming or scalding all utensils after they are washed.

TOWN AND CITY MILK SUPPLY.

The average dairy cow gives 350 gallons of milk per year, or about enough to supply 14 persons, provided it is all used as milk. But in all dairy districts more or less butter and cheese are made, and so, within reach of every town or city, there must be at least one cow for about every 12 people. Cows are kept in many villages and in some cities, but the great bulk of milk consumed in cities is produced at some distance from the closely populated section and transported to market by wagons, railroad trains, and boats. Sections are found within easy reach of all cities where dairying is the prominent pursuit and large quantities of milk are produced for shipment. Orange, Dutchess, Sullivan, and Delaware counties are the most important localities near New York City sending milk to that market. Chester County, west of Philadelphia, furnishes that city a large part of its supply. The country west and northwest of Boston furnishes most of its milk. A large part of the supply of Chicago comes from the north, but to the west and south are found excellent dairy lands from which considerable milk is shipped. These dairy sections are famous for their luxuriant pastures, pure cold springs, and fine cattle. In general, these communities are among the most prosperous of the agricultural districts of the country.

CARE OF MILK ON THE FARM.

Whether milk is delivered promptly or held some time before delivery, it needs particular care, and the best dairymen provide for this purpose a room near the stable, but separated from it so as to exclude dust and unpleasant odors. As soon as a pailful of milk has been drawn from the cows, it is carried to the milk room, poured through a fine strainer, and cooled with an apparatus made of thin metal and containing cold water. The milk flows over the outside of it in a thin sheet. After 20 or 40 quarts have been thus treated a shipping can is filled and set in cold water, or the milk is bottled and kept cold until needed. Some farmers do not use this care, but strain the milk directly into the large can, which stands in any convenient place, usually within the stable. When the can is filled it is placed (as soon as convenient) in a tub of cold water and stirred until partly cooled, then left with the cover ajar until wanted for delivery. Persons handling milk in this way do not appreciate how sensitive the fluid is to foul surroundings and how quickly it will absorb injurious odors. It is fortunate for consumers that milk shows so plainly when it has been carelessly handled. If purchasers are sufficiently watchful they can avoid being supplied with milk which has been improperly cared for. The dairyman should always bear in mind that milk is a food, and he should not leave it unnecessarily in any place where he would be unwilling to have his own food left an equal length of time.

When milk is served soon after milking, in many cases it is not cooled by artificial means, and in small towns supplied by dairymen, who drive in twice each day, it is often delivered "warm from the cow." To many persons this is a guaranty of its purity; but milk served in this way will sour in a short time. Within two or three hours after it is delivered it is likely to be nearer a condition of sourness than milk twelve or twenty-four hours older which was cooled immediately after milking and kept at a low temperature. In some cases the milk delivered in the morning is that of the previous evening, well cooled and kept in a cold place, and the milk delivered in the afternoon is the morning product similarly treated. This is a much better method than the delivery of perfectly fresh warm milk. When but one delivery is made each day, and that in the morning, the production of the same morning and previous evening are usually distributed. Many dairymen do this when they drive directly from the farm to the places of delivery, except when it is necessary to start before the hour of milking; then the milk of the morning and evening of the previous day is taken. During the hottest weather, the evening's milk is sometimes delivered by itself early in the morning, and the supply of the same morning is served later.

TRANSPORTATION OF MILK.

Necessarily most of the milk served in large cities is older than that served in towns and villages, as it has to come from greater distances, and for this reason special care is required in warm weather to prevent souring. The milk is made as cold as possible on the farm and usually held in cold spring water until time to be delivered at the railroad station. If the distance to market is great, a liberal supply of ice is kept on the cars; some railroads provide refrigerator cars. When the milk is not delivered as soon as received in the city, it is cold stored and is very cold when placed in delivery wagons the next morning. In some cases the morning's and previous evening's milk are sent into the city on trains some time during the day. If the distance is not too great and arrival in the city is early enough, the night's milk is often served as soon as received, and the morning's milk kept for early delivery on the following day. In these cases the city milkman serves milk from twelve to twenty-four hours old; but generally it is older. Railroads entering some of the large cities carry milk from points two to four hundred miles distant. Milk trains bearing the milk of the morning and the previous evening begin arriving in the cities by 8 o'clock in the morning. Those bringing milk from the more remote producing sections come in later in the day, in a few cases late in the evening. This milk is delivered the following day, being twenty-four or thirty-six hours old when it reaches the consumer. Sometimes the milk is held a half or whole day before delivery, making it that much older when consumed. Almost the entire supply of New York and some of other cities is the so-called "railroad milk."

The daily receipts in New York City are over 1,000,000 quarts (including some used in near-by cities), and practically all of this is brought by trains. Philadelphia uses about 300,000 quarts of milk per day, and, being situated in a good dairy country, a considerable part is delivered by wagons directly from the producing farms. Milk carried long distances in refrigerator cars should arrive in the city in as good condition as that which is carried but a short distance with less protection. It may seem to some that milk twenty-four or thirty-six hours old is unfit for use; but if it has been carefully handled from the first it is much better than a supply not so old and not so well cared for. Clean milk that has been cooled as soon as drawn and kept at a low temperature, will change less in two or even three days, and is therefore better, than new milk which has been carelessly handled. Thus it is possible for old milk to be *fresher*, in the usual sense of that term, than new milk.

Milk is usually transported in heavy cans, the most common sizes holding 20, 30, or 40 quarts; the styles in use differ a good deal according to locality. Within the past few years some companies have estab-

lished bottling stations near their producing farms and transport the milk in jars, which in hot weather are carried packed in cracked ice. This system has many advantages over the use of cans, but is more expensive. At the present time great quantities of milk are bottled by the dealers in their city plants.

The best conducted milk companies draw their supply regularly from the same dairies, and have contracts with the farmers requiring the milk to be produced by healthy cows, strained and cooled immediately, and sent to the city when fresh. Other provisions relate to the care of the herd and dairy, prices, etc.

DELIVERY IN CITIES.

There are as many different ways of delivering milk as there are of producing it, and not an insignificant part of the trouble which it gives is caused by neglect to properly care for it while being delivered. The large wide-mouth cans which are opened from fifty to a hundred times before they are emptied have their contents thus exposed to considerable dust and dirt. These cans are often carried without ice, even in the warmest weather, and milk can not possibly remain long in good condition when so treated. An improvement over this method is to have a faucet near the bottom of the can and an arrangement to stir the contents, so that milk of uniform quality can be drawn without exposing the entire supply. The faucet, however, should be carefully protected from dust and dirt. In warm weather the cans should be covered with ice or ice water, or at least with a wet blanket, which is some protection.

FIG. 8.—Milk jar.

The cleanest and most satisfactory way of delivering milk is in glass jars or bottles (fig. 8). Every person who is served in this way should be certain that the jars are properly cleaned as soon as emptied, and the dealer should clean and sterilize them as soon as they are collected each day. Bottles are easily cleaned, each one is a measure and prevents over or under measuring, and each bottle of milk is known to contain all the cream belonging to it. Bottles do not hide dirt in the milk, and if they are filled with fresh milk and are allowed to stand quietly a few hours cream will usually show at the time of delivery. They save the milk from being unnecessarily exposed, and if they are filled in the country the milk does not come in contact with city air until it is in the house of the consumer. This last is of considerable importance, as it has been shown that bacteria are very abundant in the atmosphere of cities, while in clean country districts but few are found in the air. The use of sealed bottles decreases the

opportunity for adulteration. Some companies serving a high-class trade with milk, for which special claims of purity are made, seal the jars, as soon as they are filled, with paraffin or metal caps or seals or sometimes with paper labels on which the time of milking may be stamped, and these must be broken before the jar can be opened. It is an excellent plan, and practically removes all chances of the milk being tampered with by driver or servant, and places all the responsibility on the one who bottles the milk; yet this is not effective unless the seal is so prepared and guarded as to prevent its being removed and replaced, or counterfeited. Objections to bottles are: They are heavy, fragile, and so useful in the kitchen that they are not always promptly returned. Paper packages to be used once and then thrown away have been suggested, but not yet perfected.

It is extremely difficult to get the last trace of dirt out of milk; some of the filth is in such fine particles that it will go through fine strainers, and later settle to the bottom of the containing vessel while the cream is rising. This sediment is objectionable and should be kept out in the first place; its presence is not a good argument against the use of jars. The fresher the milk when bottled the more easily the dirt settles, for the same reason that the fat then rises more easily. There should be no such impurity, but if it is to be present it is better to have it in the bottom of the jar than distributed through the milk and held by its viscosity, as may be the case when the milk is in large cans and stirred frequently to keep the cream evenly mixed in. Sediment is gotten rid of in some cases by allowing the milk to stand a while in large cans or vats and then drawing it off carefully for bottling. Filters for straining milk are now used with some success, and the centrifugal separators are being used by a relatively small number of concerns for cleaning or "clarifying" milk.

Large companies or firms handling the milk from many dairies often arrange to have the supply from every separate dairy served on the same route each day, so there will be as little variation as possible in the quality of the milk served to each customer, but some of them use immense tanks and mix all the milk received, which results in all deliveries being of uniform quality. Such companies generally have equipment for making butter from their surplus, so there is less temptation for them to serve old milk than if they had no facilities to "work it up." The health of each employee and his family should be carefully watched. Some companies board their help to enable them to do this.

Persons who sell milk should be reliable and should know much more about it than many of them do. For this reason it would be well if every dealer were obliged to register at the office of some local official and show that he understands something of the proper handling of milk and is able at least to apply some approved test for fat. The registration of milk dealers is now required in some cities.

PRICE OF MILK.

Farmers producing milk for shipment to city dealers usually receive from 2 to 5 cents per quart in different parts of the country. The price of course depends mainly on supply and demand, but the quality and condition of the milk produced are factors of importance, and the better price commanded by the higher grade product serves as an incentive for the farmer to keep the best cows and adopt the best methods.

The price which the farmers receive varies somewhat with the season of the year, ranging from 2 to 3 cents per quart in summer, while the winter price is about a cent higher. This difference is necessary to induce the farmers to produce milk during the winter when the cost of feed makes production more expensive. In some localities farmers receive less than 2 cents per quart in the summer. This low price tends to encourage the keeping of cows which give a large flow of (usually poor) milk, and the cheapest possible maintenance.

The way milk is handled greatly influences its cost to the producer. If the business is carried on in a slipshod way, milk can be sold at a profit for a low price. But the product of a good herd, well fed and cared for, that has received care in all particulars from the moment it came from the cow and perhaps is served in expensive glass jars, should command a fair price. The extra cost of good stock and buildings, reliable help, the best feed, veterinary and chemical supervision, and superior methods of delivery is considerable, and all should admit that milk produced with such aids is much more desirable and worth more than that produced and handled in a careless manner. *The failure of the general public to recognize this fact and act accordingly is one of the chief reasons for the slow improvement of city milk supplies.*

Other things being equal, the price of milk should depend on its richness. It is most unreasonable for milk containing but 3 per cent of fat to sell for the same price per quart as 5 per cent milk. Many regard all milk as the same, and are satisfied as long as it is sweet and cheap; they are unwilling to pay more for one quality than another. This is just the same as it would be to expect to purchase sirloin steak for the price of round, or the finest of flour for the price of a poorer quality. Four quarts of good milk may contain as much food value as 5 quarts of poor milk, and as it costs more to produce a rich than a poor milk, it is right that it should sell for more.

One thing which adds greatly to the expense of delivering milk in cities is the long distance that has to be traveled to serve a small amount of milk. Sometimes every house in a block is served by a different peddler, and yet all get practically the same kind of milk. This condition can not be easily changed while competition is so strong; but it would be a long step toward reformation and economy in the milk business if consumers and peddlers would cooperate so as to avoid this useless waste of labor.

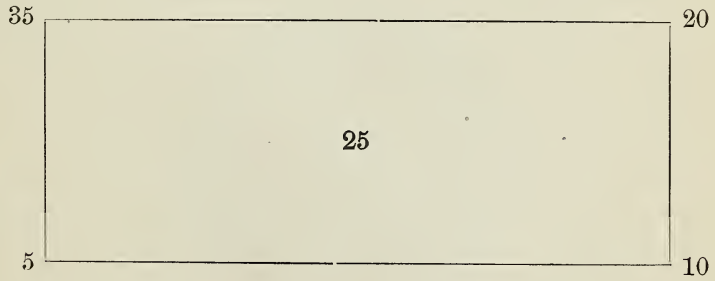
STANDARDIZING MILK AND CREAM.

It is coming to be a more and more common practice to standardize milk and cream before sale. This means the adjustment of the fat content to a certain desired percentage, and it is accomplished by mixing, in the proper proportion, milk and cream, or two qualities of milk or cream, one richer and one poorer than the desired standard quality. The use of skimmed milk would be prohibited for a milk mixture by the laws of some States and the ordinances of some cities. But normal milk of low enough fat content can usually be found for all requirements.

An easy way to determine the relative amounts of the two milks or creams to be mixed is given in the following rule:

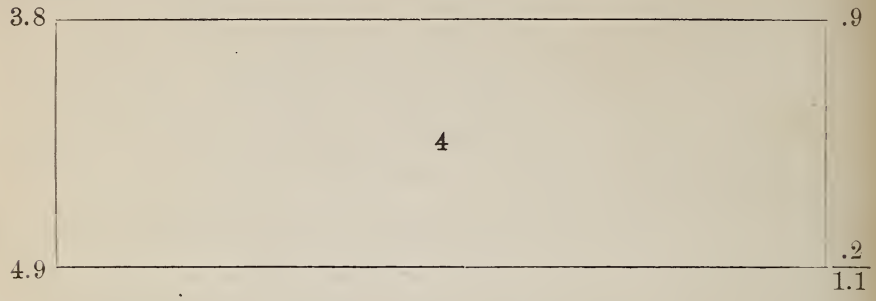
Draw a rectangle (see accompanying diagrams) and write at the two left-hand corners the percentages of fat in the two fluids to be mixed and in the center place the standard percentage desired. Then find the difference between the number in the center and that at the upper left-hand corner, and place this at the opposite corner—the lower right-hand corner. In like manner place at the upper right-hand corner the difference between the number in the center and that at the lower left-hand corner. Now the number at the *upper right-hand* corner shows the relative number of pounds of the milk or cream whose percentage stands at the *upper left-hand* corner, which should be used in making the mixture; and the number at the *lower right-hand* corner shows the relative amount which should be used of the milk or cream whose percentage stands at the *lower left-hand* corner.

For example: Suppose we have a cream testing 35 per cent fat and a milk testing 5 per cent fat, and we want to mix them in such ratio as to produce a 25 per cent cream. Following the rule, we have this diagram:



This shows that 20 parts of the 35 per cent cream should be combined with 10 parts of the 5 per cent milk to produce 30 parts of the 25 per cent cream. In other words, the two may be combined in the ratio of 20 to 10 (or 2 to 1) to produce any desired quantity of cream testing 25 per cent fat.

Or suppose it is desired to mix milk testing 3.8 per cent fat with milk testing 4.9 per cent so as to produce 200 pounds of milk testing 4 per cent fat. The diagram will appear as follows:



Discarding the decimal points for convenience, we can now make up the 200 pounds of 4 per cent milk by taking $\frac{9}{11}$ (or 163.64 pounds) of the amount from the milk testing 3.8 per cent and $\frac{2}{11}$ (or 36.36 pounds) from the milk testing 4.9 per cent fat.